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ENTITLED

TEST FIXTURE ASSEMBLY FOR PRINTED CIRCUIT BOARDS

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TEST FIXTURE ASSEMBLY FOR PRINTED CIRCUIT BOARDS

CROSS-REFERENCE TO RELATED APPLICATION

The present application claims priority to Provisional Application Serial No. 60/255,262 filed December 11, 2000 and entitled "PNUEMATIC ACTUATED CLAMP SYSTEM."

FIELD OF THE INVENTION

The present invention relates generally to a test apparatus and associated method for circuit boards and more, particularly, but not by limitation to a circuit board test apparatus and method adaptably interfacing to different circuit board configurations.

BACKGROUND OF THE INVENTION

Circuit board operation is tested prior to assembly of circuit boards in various products to verify operational integrity of the circuit board components. For test operations, an electrical connection or interface is made between the circuit components of the circuit board and test equipment or a test engine. The electrical connection or interface between the test equipment and the circuit board is established through a test fixture. The test fixture includes first and second interfaces including a plurality of terminals and the test fixture includes a plurality of leads electrically connecting the plurality of terminals on the first interface to the plurality of terminals on the second interface. For test operations, terminals on the first interface electrically couple to terminals or probes on the test equipment and terminals on the second interface electrically couple to terminals of a circuit board under test.

Different circuit board designs have different terminal or electrical configurations and thus different test fixtures with different terminal or electrical configurations are used to test different circuit board configurations. Test fixtures are removably coupled to the test equipment to install different test fixtures depending upon the circuit board configuration under test. For accurate test operations, terminals on the first interface of the test fixture must be

accurately aligned with terminals or probes of the test equipment and terminals on the second interface must be accurately aligned with terminals on the circuit board under test to assure proper electrical connection between the test equipment or assembly and the circuit board. The process of aligning and assembling the test fixture relative to the test assembly can be time consuming and alignment can be difficult slowing test operations. Embodiments of the present invention address this and other problems and provides advantages and features not recognized nor appreciated by the prior art.

SUMMARY OF THE INVENTION

The present invention relates generally to a test system for testing operation of a circuit board. The test system includes a fixture for providing an electrical interface between a test engine or device and a particular circuit board. The test fixture is selectively clamped and/or loaded onto an actuator which moves the fixture from a first position spaced from the test device to a second position where the test fixture is electrically connected with circuitry of the test device for installation. These and various other features as well as advantages which characterize embodiments of the present invention will be apparent upon reading the following detailed description and review of the associated drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic illustration of a test system for printed circuit boards.

FIG. 2 is an exploded illustration of a test assembly for coupling terminals on a printed circuit board to a test engine or test equipment.

FIGS. 3-1 through 3-4 are schematic illustrations of an embodiment of a test system in accordance with an embodiment of the present invention progressively illustrating installation of a test fixture relative to a test engine or equipment for testing operations.

FIGS. 4-1and 4-2 schematically illustrate an embodiment of a clamp shown in a first position or orientation for loading a fixture for installation.

FIGS. 4-3 and 4-4 schematically illustrate the embodiment of the clamp shown in FIGS. 4-1 and 4-2 in a clamped position or orientation for installation of the test fixture.

FIG. 5 is a perspective illustration of an embodiment of a test fixture including opposed mounting ledges for loading and clamping the fixture for installation.

FIG. 6 is a flow chart illustrating operating steps for testing a printed circuit board.

DETAILED DESCRIPTION OF ILLUSTRATIVE EMBODIMENTS

FIG. 1 is a schematic illustration of a test system 100 for a printed circuit board 102. As shown, the test system 100 includes a test engine or device 104 illustrated schematically which electrically interfaces with the circuit board 102 for test operations through a test fixture 110. In the illustrated embodiment shown in FIG. 1, the system includes a cover 112 which is electrically coupled to the test engine 104 and electrically interfaces with the circuit board 102 for test operations. A particular circuit board 102 under test is positioned relative to the fixture 110 and the cover 112 to electrically couple to the test engine 104 through terminals on the fixture 110 and cover 112 and preset terminals or probes 114 on the test engine 104.

In the fixture embodiment shown, fixture 110 includes a first interface surface 116 including a plurality of terminals 118 and a second interface surface 120 also including a plurality of terminals 122. As shown in FIG. 1, the first and second interface surfaces 116, 120 are orientated in opposed directions. The fixture 110 is installed as illustrated by line 126 relative to test engine 104 so that terminals 118 on interface surface 116 operably couple to selected terminals or probes 114 on the test engine 104. For test operations, terminals 122 on interface surface 120 couple to terminals 124 on the circuit board 102 under test.

Terminals 118 are electrically coupled to terminals 122 as illustrated schematically by lines 128 to provide an electrical interface or connection between the circuit board 102 under test and the test equipment or test engine 104.

In the illustrated embodiment cover 112 includes a plurality of terminals 130. For a test cycle, cover 112 is lowered or moved towards fixture 110 as illustrated by arrow 132 so that terminals 124 on the circuit board 102 electrically couple to the test engine 104 through terminals 130 on cover 112. For test operations, test engine 104 provides a test voltage or current to test operation of the circuit board 102. As previously described different circuit boards have different configurations and terminal arrangements. Thus different fixtures are installed for test operations depending upon the design of the circuit board being tested.

FIG. 2 illustrates an assembly arrangement for installing a particular fixture to electrically couple a circuit board 102 being tested to the test engine 104. In the embodiment shown in FIG. 2, fixture 110 is assembled relative to an adapter plate 140 coupled to the test engine or device 104 by vacuum pressure supplied through a vacuum port 142. As shown, vacuum pressure is supplied through vacuum port 142 so that the fixture 110 is biased toward terminals (not shown) on the adapter plate 140 to provide an electrical connection between the circuit board 102 and the test engine 104. Maintaining proper alignment of the fixture interface can be difficult if there is not proper air sealing between the components or there is warpage of the components of the system. Alignment difficulties can slow testing operation and reduce testing reliability

Embodiments of the present invention relates to a test system including an installation assembly to selectively install a particular fixture for test operations. FIGS. 3-1 through 3-4 schematically illustrate an embodiment of a test assembly to install different fixtures relative to test engine 104 for testing different printed circuit boards, where like numbers are used to refer to like parts

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in the previous FIGS. As shown in FIGS. 3-1 through 3-4, the assembly includes a clamp assembly 144 and an actuator 146 to install a clamped fixture 110 relative to the test engine 104 for installation of different fixtures for different circuit board configurations.

As shown in FIGS. 3-1 and 3-2, clamp assembly 144 is coupled to actuator 146 and movable thereby so that fixture 110-1 is clamped relative to the actuator 146 and so that actuator 146 moves fixture 110-1 as illustrated by arrow 150 between an extended or raised position shown in FIG. 3-1 and an installed position shown in FIG. 3-2 to install the fixture for test operations. In the extended or raised position shown in FIG. 3-1, the fixture 110-1 is spaced from the test engine 104 and in the installed position shown in FIG. 3-2, the fixture is lowered towards the test engine 104 to electrically couple the fixture 110-1 to the test engine 104.

In the embodiment shown, a pneumatic piston-cylinder actuator is used to move the fixture 110-1 between the extended or raised position and the installed position to install a particular fixture for test operations. Guide pins 160 on the adapter plate 140 insert into guide holes 162 on the fixture 110-1 to align the fixture 110-1 for installation. Although a pneumatic piston cylinder is described, application is not so limited and alternate actuator systems can be employed to move the supported fixture between the raised position and installed position.

FIGS. 3-3 and 3-4 illustrate an operating sequence embodiment for testing a circuit board through the fixture interface. As shown in FIG. 3-3, the circuit board 102 is aligned relative to the fixture 110-1. In the embodiment shown, a cover 112-1 is moved towards fixture 110-1 via actuator 164 as progressively illustrated in FIGS. 3-3 and 3-4. Cover 112-1 is lowered towards fixture 110-1 so that guide pins 166-1, 166-2 on cover 112-1 extend into guide holes 168-1, 168-2 on the fixture 110-1 to align the cover 112-1 relative to the fixture 110-1 for accurate interface connection.

Cover 112-1 also includes guide pins 166-3, 166-4 which extend through holes on the circuit board 102 and fixture 110-1 as illustrated in FIG. 3-4 to align the circuit board 102 to be tested with the fixture base 110-1 and cover 112-1. Also, as shown, fixture 110-1 includes guide pin 169 for insertion through circuit 102 to align the circuit board 102 relative to the test fixture 110-1. Thus, as shown progressively illustrated in FIGS. 3-3 and 3-4, actuator 164 lowers cover 112-1 to bias the circuit board 102 being tested toward fixture 110-1 and to electrically couple terminals on the circuit board 102 to the fixture terminals and cover for electrical interface with the test circuitry of the test engine 104.

In the illustrated embodiment of FIGS. 3-1 through 3-4, fixture 110-1 includes a test board 170 including a plurality of test terminals (not shown) to form the first interface 116 to couple the fixture 110-1 to terminals or probes of the test engine 104. A plurality of probes or pins (not shown) are coupled to the test board 170 to provide an electrical interface between terminals on the test board 170 and terminals 122 on the second interface 120 formed by a tip portion of the pins or probes. Although a particular fixture circuit structure has been described, it should be understood that application of embodiments of the present invention is not limited to the fixture structure embodiment described.

FIGS. 4-1 through 4-4 illustrate an embodiment of a clamp assembly 144-1 to install fixture 110-1 relative to the test engine 104 where the fixture 110-1 is loaded, clamped and installed relative to the test engine for test operations. As shown, clamp assembly 144-1 includes first and second clamp members 172, 174 supported in spaced relation. Clamp member 174 includes an enlarged head 176 to form a support surface to load fixture 110-1 for assembly by actuator 146 as shown in FIGS. 4-1 and 4-2. Clamp member 172 includes a head 178 having an elongated dimension 180 and a narrowed dimension 182 as shown in FIG. 4-2. Fixture 110-1 includes a clamp opening 184 also shaped with an elongated length dimension and a narrowed dimension so that the head

178 of clamp member can be inserted through opening 184 in a first orientation with the elongated length dimension 180 aligned with the elongated length dimension of clamp opening 184 to load the fixture for installation as illustrated in FIGS. 4-1 and 4-2. The enlarge head 176 of clamp member 174 restricts insertion of clamp member 174 through opening 184 to support the fixture 110-1 to load the fixture for installation.

To clamp the fixture for installation, a clamp rotator 186 rotates the clamp member 172 from a first orientation where the elongated length 180 is aligned with the elongated length dimension of clamp opening 184 as shown in FIGS. 4-1 and 4-2 to a second orientation shown in FIGS. 4-3 and 4-4. In the second orientation, the elongated length 180 of the clamp member 172 is aligned with the narrowed dimension of clamp opening 184. The clamp members 172, 174 are spaced relative a thickness of a ledge 188 portion of the fixture 110-1 having the clamp opening 184 so that in the second orientation, the elongated length 180 of clamp member 172 abuts a surface 190 of fixture 110-1 while surface 192 of fixture 110-1 is supported on enlarge head 176 of clamp member 174 to secure fixture 110-1 therebetween. Thereafter, actuator 144 moves clamp members 172, 174 (with the fixture 110-1 secured therebetween) toward the test engine 104 as shown in FIG. 3-2 to install the fixture. Thus, as described, fixture 110-1can be easily loaded for test operations without extensive installation delay. Although a particular clamp structure is illustrated in FIGS. 4-1 through 4-4 for loading and clamping the fixture for installation, application is not limited to the particular structure shown.

Subsequent to use for a particular circuit board, the test fixture 110-1 is unloaded. The test fixture 110-1 is unloaded by extending actuator 146 to bias head or support surface 176 against fixture 110-1 to raise fixture 110-1. Thereafter, rotator 186 rotates clamp member 172 to unclamp the fixture 110-1 and the fixture 110-1 is removed to install a different test fixture if desired. FIG. 5 is a perspective illustration of an embodiment of a test fixture 110-1. As

shown, the test fixture 110-1 includes opposed side ledges 188-1, 188-2 including spaced clamp openings 184 to secure the fixture 110-1 to multiple actuators for installation. In the illustrated embodiment each side ledges 188-1, 188-2 includes openings 184-1, 184-2 positioned on opposed ends of ledges 188-1, 188-2 to secure the fixture 110-1 for installation proximate to four corner of the fixture. Although, the test fixture 110-1 shown in FIG. 5 includes four clamp openings, application of the assembly of the present invention is not limited to the particular embodiments shown.

FIG. 6 is an operation flow chart for testing circuit boards of different configurations in accordance with one embodiment of the present invention. As shown a fixture for a particular circuit board under test is loaded for installation and clamped or secured to the actuator assembly as illustrated in block 190. The actuator assembly is operated pneumatically or otherwise to lower the clamped fixture to install the fixture relative to the test device for operation as illustrated by block 192. The circuit board being tested is electrically coupled to the fixture as illustrated by block 194 and operation of the circuit board is tested as illustrated by block 196. Sequential circuit boards are electrically coupled to the fixture as illustrated by line 198 for testing operations. As illustrated by line 200 the fixture is unloaded and a different fixture is installed to test a circuit board having a different design or configuration.

A test system for testing operation of a circuit board, the test system includes a fixture (such as 110-1) for providing an electrical interface between a test engine or device (such as 104) and a particular circuit board (such as 102). The test fixture is selectively clamped (such as 146) to an actuator (such as 144) which moves the fixture from a first position spaced from the test engine or device to a second position to electrically interface with circuitry of the test engine.

It is to be understood that even though numerous characteristics and advantages of various embodiments of the invention have been set forth in the

foregoing description, together with details of the structure and function of various embodiments of the invention, this disclosure is illustrative only, and changes may be made in detail, especially in matters of structure and arrangement of parts within the principles of the present invention to the full extent indicated by the broad general meaning of the terms in which the appended claims are expressed. For example, the particular elements may vary depending on the particular application while maintaining substantially the same functionality without departing from the scope and spirit of the present invention. In addition, although preferred embodiments are described herein, it will be appreciated by those skilled in the art that the teachings of the present invention can be applied to other systems, without departing from the scope and spirit of the present invention.